Space Weather Technical Forecast

Issued on Tuesday, 04 April 2023 at 12:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of Minor Geomagnetic Storms on 04 and 05 Apr. Periods of Active electron fluence expected 04 and 05 Apr. Slight chance of M-class flares (R1-R2; Minor-Moderate radio blackouts) throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low with no significant flare activity. There are three active regions on the visible disc, with one rotating away from view across the western horizon. AR3270 is the most prominent region on the visible disc, but has simplified and now longer contains a delta spot. The two remaining regions are both simple and inactive. No Earth-directed CMEs have been observed on available imagery.

Solar Wind / Geomagnetic Activity: The solar wind, as observed at L1, has averaged between around 490km/s and 550km/s as the Earth is affected by coronal holes 89 and 90, along with the waning influence of coronal hole 88. Density has been steady and around average throughout. Magnetic field strength, Bz, has been weak, with the north-south component, Bz, only varying weakly. Phi angle was predominantly negative, towards the Sun. Geomagnetic activity was mainly Quiet to Active.

Energetic Particles / Solar Radiation: High energy proton enhancement (greater than 10MeV) has been at background levels. The high energy electron flux (greater than 2MeV), as measured at GOES16 reached a peak of 4.26e3 pfu at 03/1515UTC. This has since varied between moderate and background levels, briefly reaching high levels between 04/0300 and 04/0500UTC. Electron fluence has followed a declining trend from a peak of 1.31e8 integrated pfu at 04/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Expected to be mainly Low, with a slight chance of Moderate activity.

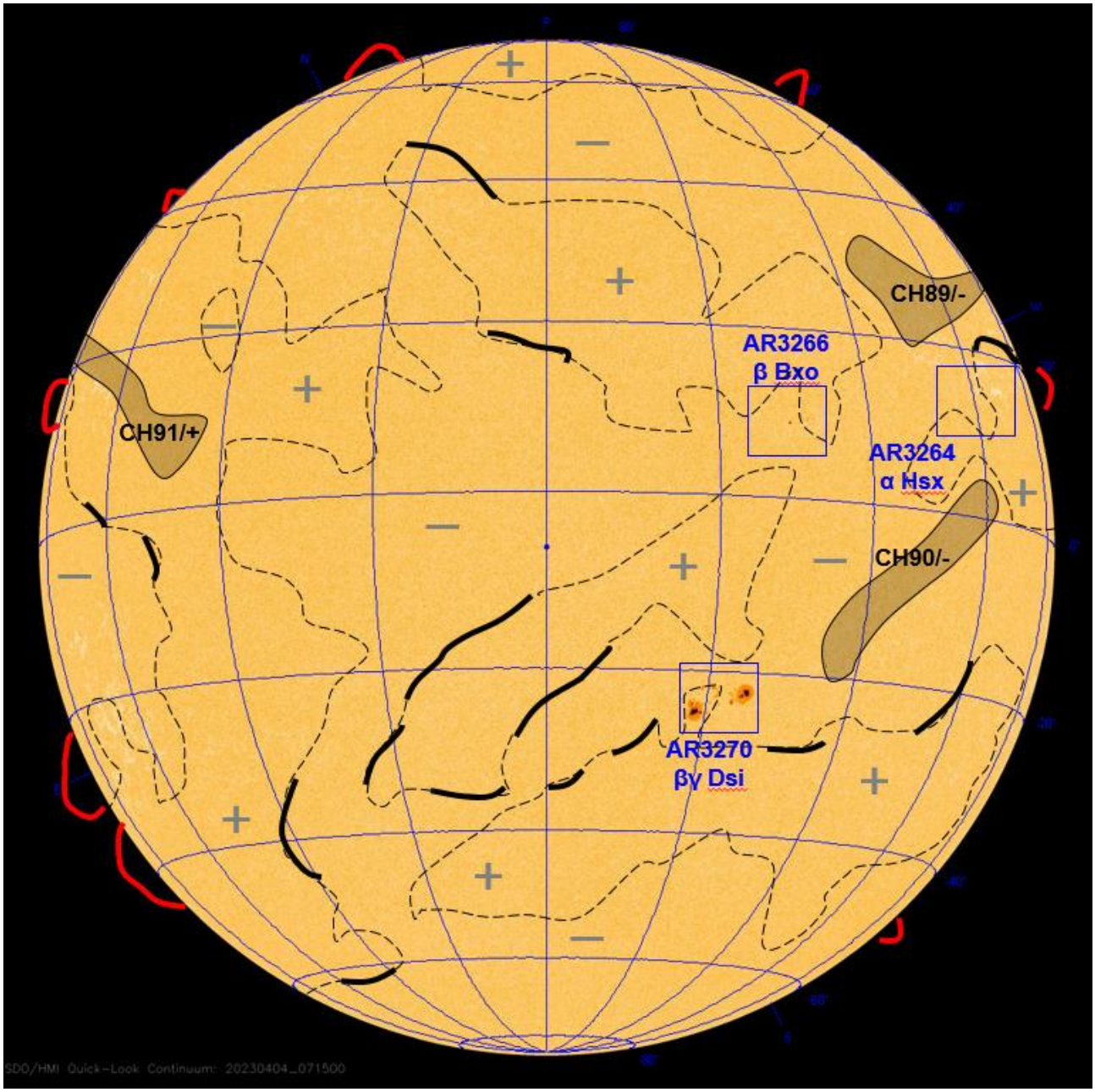
Solar Wind / Geomagnetic Activity: No Earth-directed CME are expected, with a very low chance of a glancing blow on 04 Apr. A combination of high speed streams are currently affecting the Earth, reaching speeds of between 500-550km/s. These are expected to start to decline through 06 and 07 Apr. No further coronal hole high speed streams are then expected to connect to the Earth. Geomagnetic activity is forecast to be mainly Unsettled to Active through 04 and 05 Apr, with a risk of G1/Minor Storms in any sustained periods of negative Bz. A trend towards mainly Quiet to Unsettled conditions is then expected through the remainder of the forecast period.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as observed by GOES-16 is at background levels and is expected to remain so pending any significant sunspot development. Electron flux values are expected to vary between moderate and high levels, with a decline in the magnitude of the diurnally high peaks. Electron fluence is forecast to decline, but there is a chance that both flux and fluence could increase towards the end of the period as the high speed stream eases and the radiation belts relax.

Figure 1. Solar Analysis Valid 04/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Geomagnetic Storms:

A number of weak CMEs have been observed over the last few days, but none of these are considered to be likely to affect the Earth.

Solar wind speeds are around slightly elevated or elevated levels due to a combination of a number of coronal hole high speed streams. coronal hole 88 has rotated across the western horizon and is likely to have a waning influence. Coronal holes 89 and 90, negative polarity holes are both geoeffective and due to their locations, will affect the Earth through much of the forecast period.

Geomagnetic activity is forecast to be mainly Active through 04 April and 05 April. As the coronal holes are both negative polarity, they are favoured for a stronger connection to the Earth's magnetic field close to the March equinox. Therefore there is a risk of G1/Minor Storm intervals in any sustained periods of negative Bz. The effects are then likely to wane as the high speed streams ease later in the period with a trend towards mainly Quiet to Unsettled geomagnetic activity.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	30	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: 24 hour solar wind observations

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

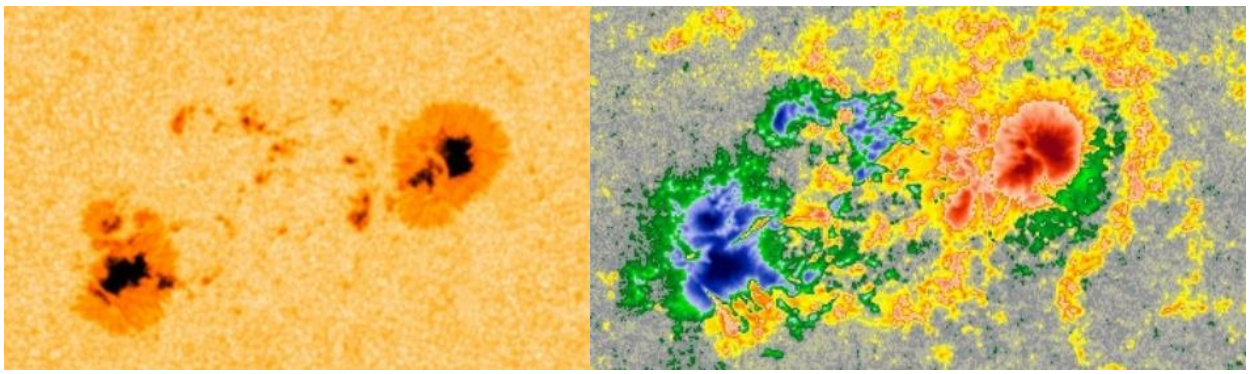
© Crown Copyright 2023. All Rights Reserved.

Radio Blackouts - X-Ray Flares:
There are only three relatively stable sunspot regions on the visible disc, all of these in the western hemisphere. AR3270 presents the highest risk of flare activity, having a history of a delta spot, but presents a decreasing risk. Two remaining regions are both simple, with no significant regions expected to rotate onto the eastern horizon in the next four days.

Solar activity is forecast to remain Low, with a slight chance of Moderate activity.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	15	15	15	15
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: AR3270 in the southwest quadrant on SDO HMI intensitygram and magnetogram imagery



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):
High energy proton flux (greater than 10MeV), as observed by GOES-16 is forecast to remain at background levels, pending any significant sunspot development. Any notable flare activity from AR3270 gives the greatest risk of levels reaching S1, although this has simplified over the last 24 hours, losing a delta region.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) is forecast to continue to oscillate between moderate and high (1e3 pfu) levels through the forecast period, due to the continued input of electrons from the high speed streams. The magnitude of the peaks may decline later in the period as the high speed streams ease. The British Geological Survey radiation belt model (BAS-RBM) is forecasting that many of the electrons are held in below GEO orbits, so there is a small chance that a forecast decline in solar wind speeds (and consequently solar wind pressure) could lead to an expansion of high density of electrons towards GEO orbit. However the most likely scenario is for the suggested decline in electron counts, with a low risk of an increase towards the end of the period as the high speed stream eases.

Electron fluence values are declining, with the MOSWOC REFM model under-forecasting the level of the electron fluence, with a declining trend accepted as a most likely scenario. A slight risk of an increase towards the end of the period represents the assessment that the radiation belts may relax back towards GEO orbits. Any significant geomagnetic activity, could lead to a sharper decline in both electron flux and fluence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	60	20	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.